# Microwave Wireless Power Transmission Development Task

Presentation to Space Solar Power Concept and Technology Maturation Program Technical Interchange Meeting

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# Retrodirective System

- Pilot beam from receiving antenna
  - Phase detected across antenna face
  - Phase information used to create conjugate phase information for power beam steering
- Transmitting antenna
  - Modular phase shifted transmitting elements
- Rectenna
  - Efficient low power density conversion

# Current Retrodirective WPT Demonstration Project

Features:

- Demonstration of a 5.8 GHz microwave power beam
- Phased Array Transmitting Antenna
  - 2.1 ft by 5.25ft
  - 10 subarrays, 2 active subarrays transmitting 40 watts each
  - 25.7 db gain, $4.5^{o}$ 3 dB beamwidth (2-sided)
- Retrodirective Phase Control of Beam
  - One phasing transmitter in center of rectenna
  - Two subarray receivers in transmit antenna
  - Photonics system used to distribute phase reference to each subarray
- Receiving Rectenna
  - Approximately 39 inches diameter
  - Low power half-wave dipole circular polarization elements

Features Continue:

- Completely safe

    - Power density in center of beam = 2.4 mW/cm$^2$
      (less than 1/2 of the acceptable safety level for short-term exposure as per NSTS 1700.7B

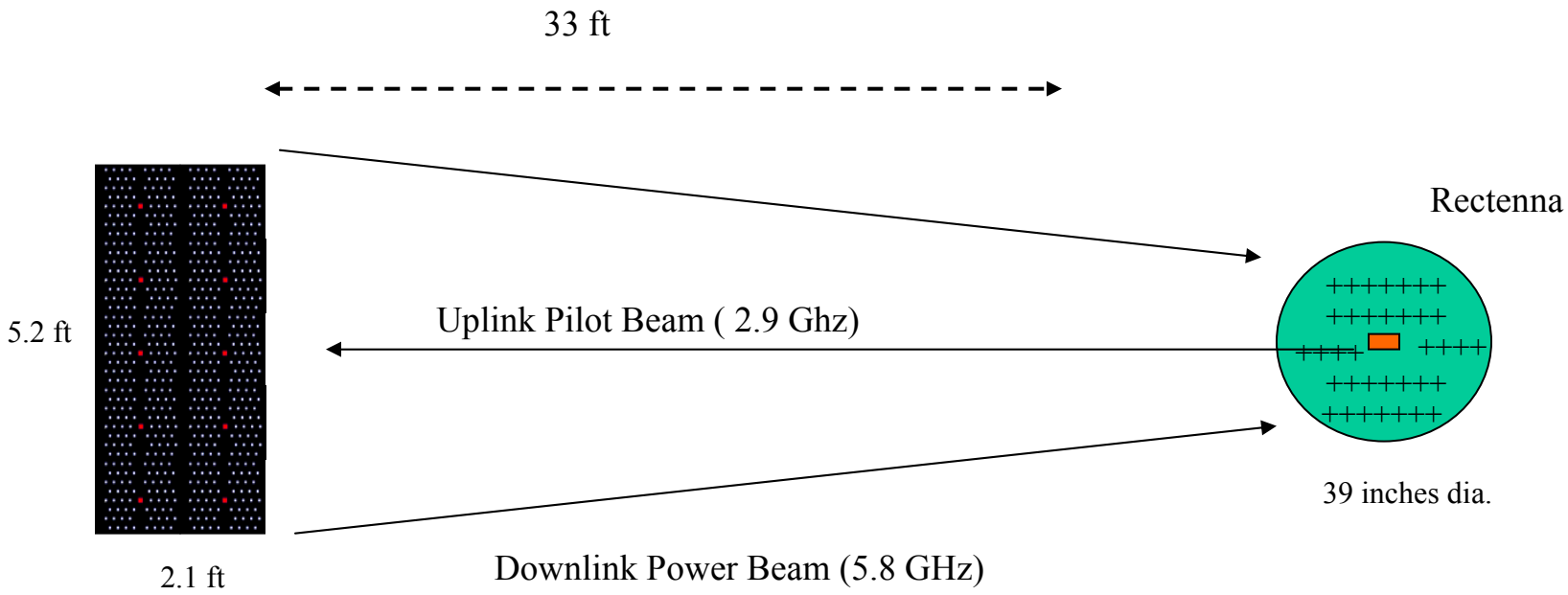
- Other

    - Light weight, portable, operates 120 volt, 60 Hz electrica outlet
    - Range = 33 feet

        - Demonstrates safety feature of retrodirective phasing,
          (loss of phasing signal disperses the power beam)

        - Grating lobe demonstration by physically separating the active subarrays

# Exhibit System Diagram




Transmitting Antenna

10 subarrays: 2 active, 8 inactive

## Demonstrates:

Wireless Power Transmission (85% transfer efficiency)
Retrodirective Phase Control of Power Beam
Photonics Phase Distribution System in Transmit Array
Grating Lobe Characteristics

# Antenna Characteristics

## Transmit Antenna

- **10 subarrays: 2 x 5 in a rectangular configuration, 2 active, 8 inactive**
  - **63 transmit patch antennas and 1 receive patch antenna per subarray**
  - **The 63 transmit patches are fed with equal phase**

- **Transmit power: Approximately 80 watts from the total array**

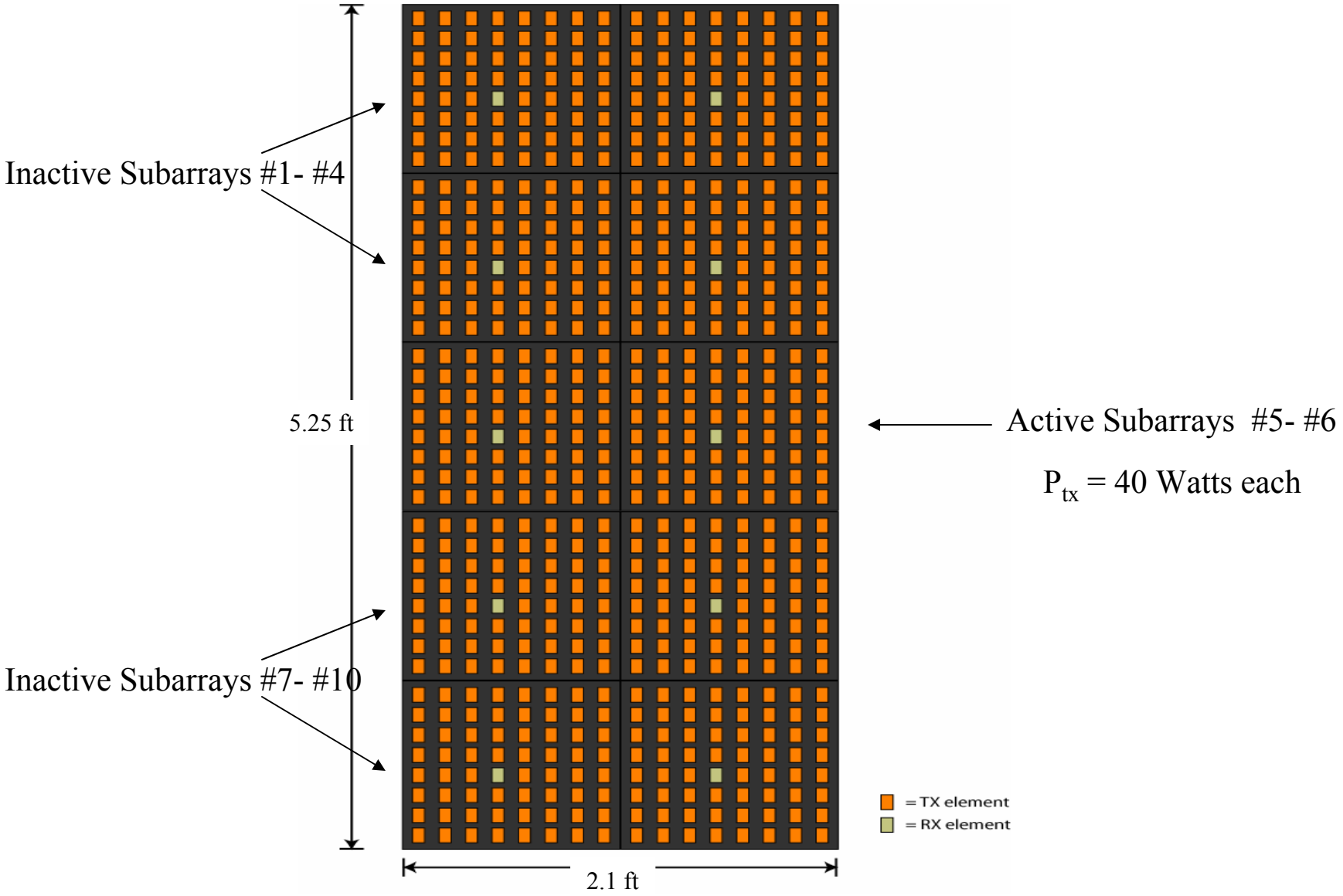
- **Frequency**
  - **Downlink Power Beam = 5.8 GHz**
  - **Uplink Pilot Signal = 2.9 GHz**

**NOTE: The frequencies are separate due to the need for isolation between transmit and receive. The uplink and downlink also have polarization diversity, i.e. RCP and LCP**

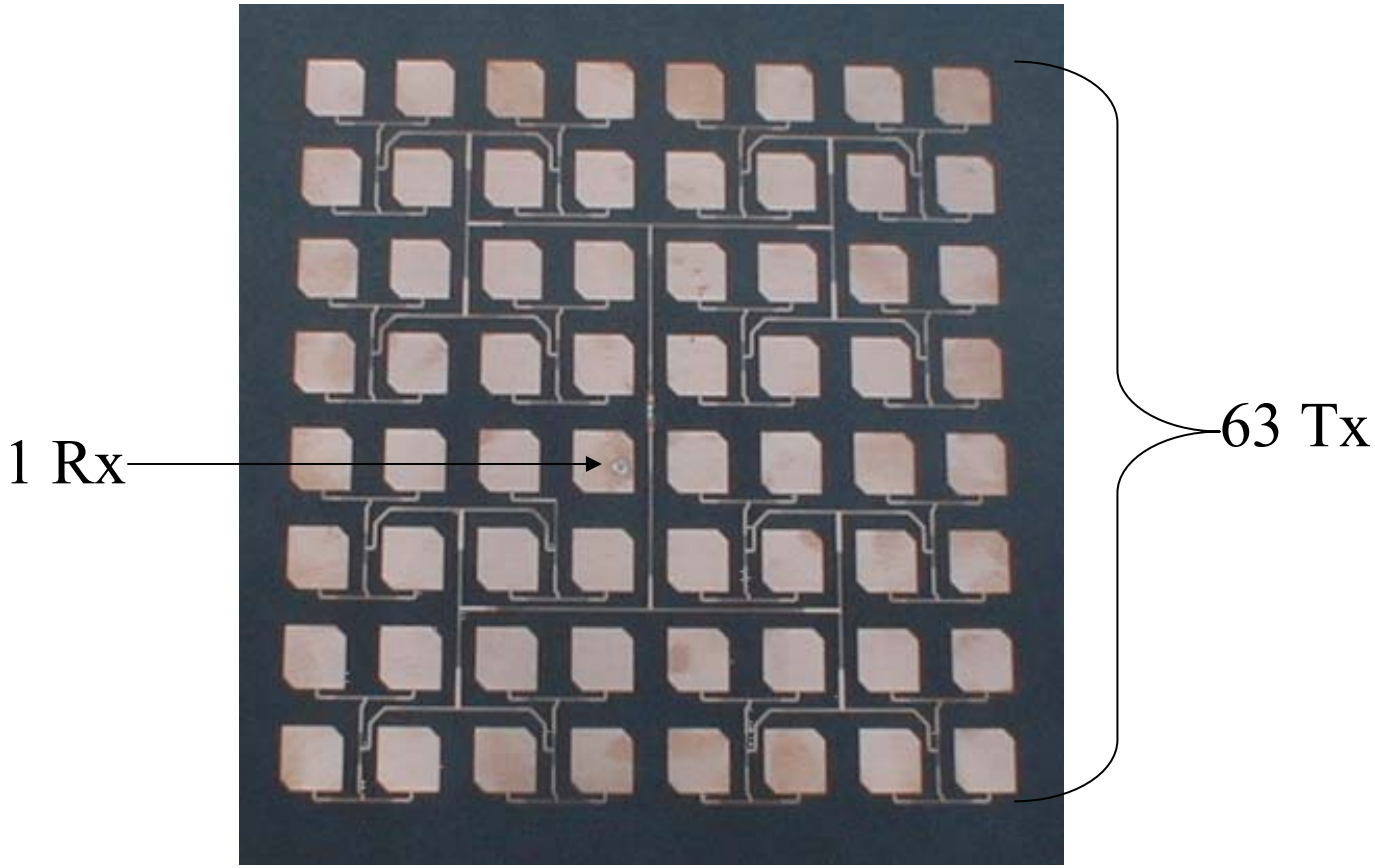
## Receive (Pilot Beam) Antenna

- **Each of the 2 active subarrays have an uplink receive channel including the receive patch antenna and associated electronics.**

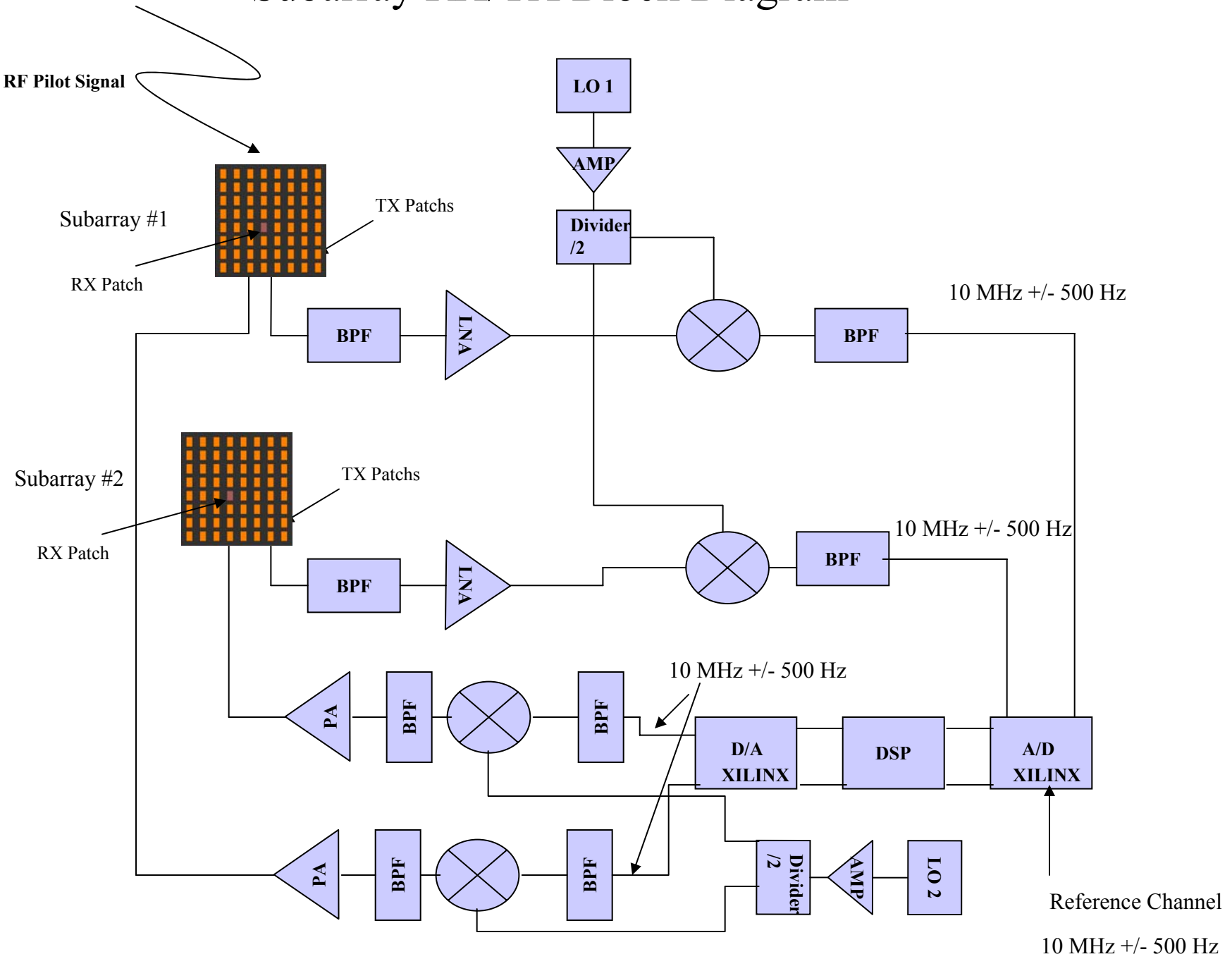
# Antenna Configuration



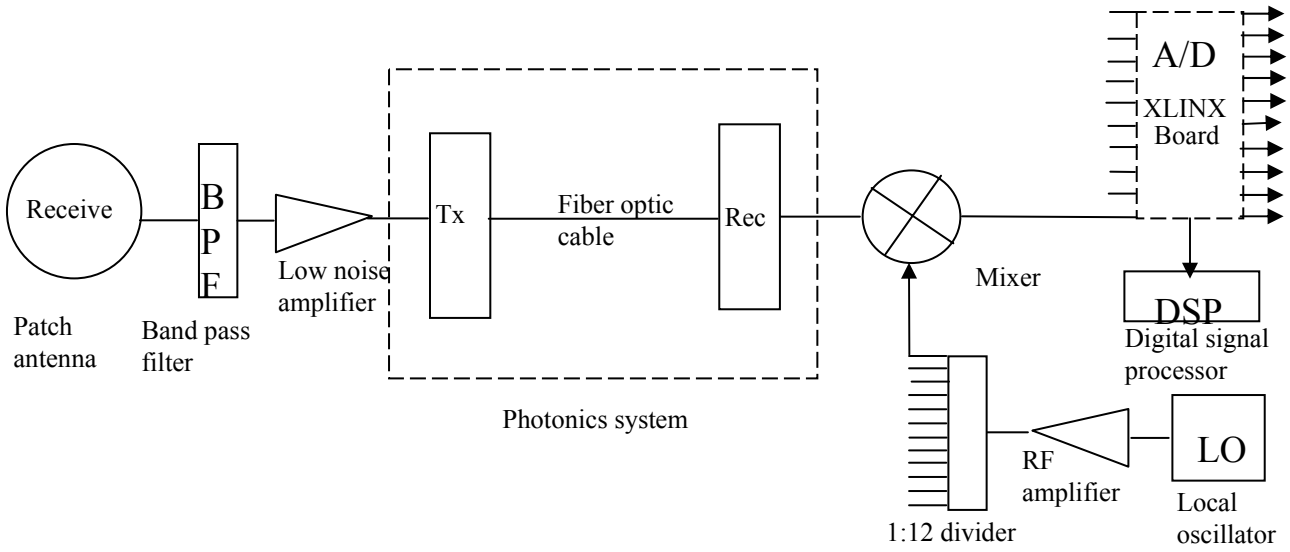
# Equal phase transmitter module with pilot receiving antenna



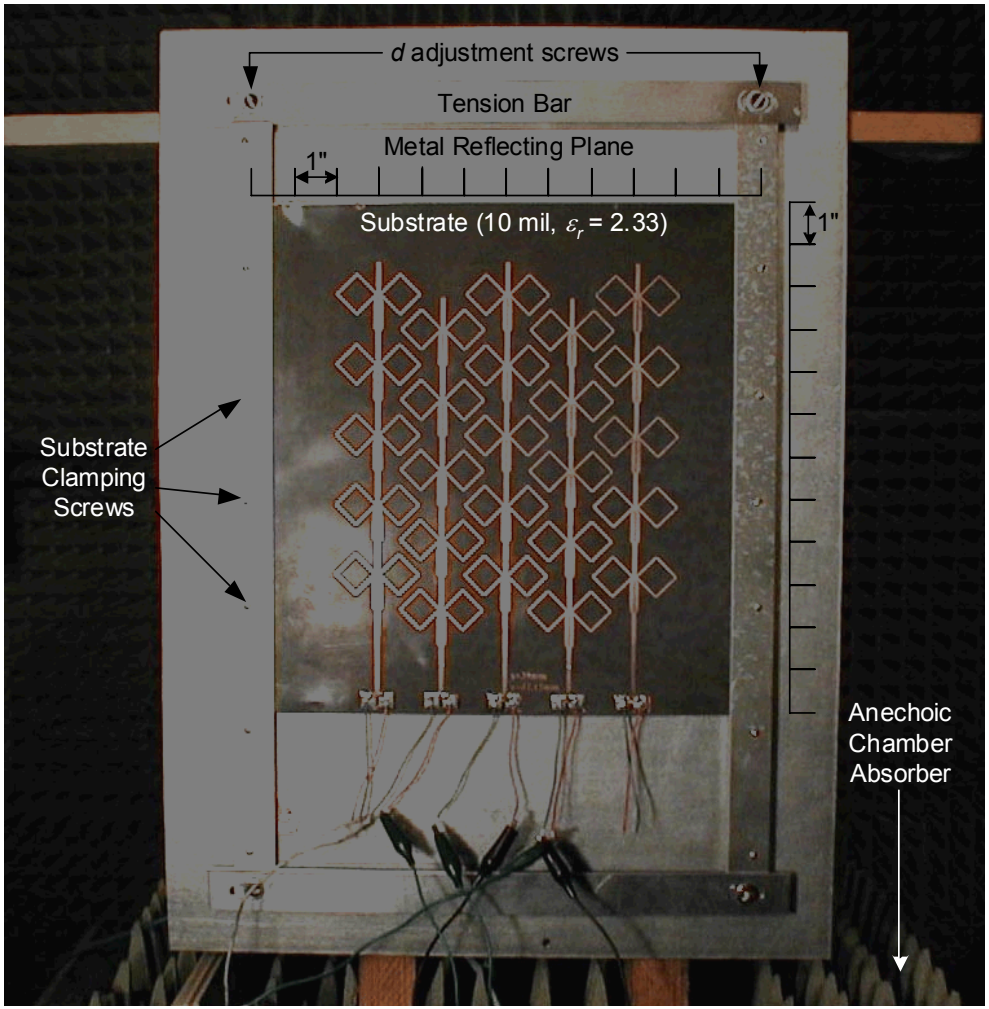
# Subarray RX/TX Block Diagram



# Reference channel with photonic distribution system



# Circular Polarized Rectenna



# NSF/NASA/EPRI task

- Build a 2X2 array with retrodirective control
- Improve the low-power density conversion efficiency of the rectenna elements.
- Demonstrate, test and measure target tracking, beam steering, beam pattern and transmission and system efficiency